



CABA Intelligent & Integrated Buildings Council (IIBC)



# CABA White Paper

## **On Intelligent Home Offices – A Model and Potential Impacts**

Dr. Albert So, Asian Institute of Intelligent Buildings (Main Author)

Dr. Kwok C. Wong, The University of Hong Kong

Dr. Kenneth Wacks, Ken Wacks Associates

David Katz, Sustainable Resources Management Inc.



## WORKING GROUP

**Asian Institute of Intelligent Buildings**, Dr. Albert So

**The University of Hong Kong**, Dr. Kwok C. Wong

**Ken Wacks Associates**, Dr. Kenneth Wacks

**Sustainable Resources Management Inc.**, David Katz

**Public Works and Government Services Canada**, Marek Dziedzic



## ABOUT CABA

The Continental Automated Buildings Association (CABA) is an international not-for-profit industry association, founded in 1988, and dedicated to the advancement of intelligent home and intelligent building technologies. The organization is supported by an international membership of over 300 organizations involved in the design, manufacture, installation and retailing of products relating to “Internet of Things, M2M, home automation and intelligent buildings”. Public organizations, including utilities and government are also members. CABA's mandate includes providing its members with networking and market research opportunities. CABA also encourages the development of industry standards and protocols, and leads cross-industry initiatives. CABA's collaborative research scope evolved and expanded into the CABA Research Program, which is directed by the CABA Board of Directors. The CABA Research Program's scope includes white papers and multi-client market research in both the Intelligent Buildings and Connected Home sectors. (<http://www.CABA.org>)



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## Summary

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The idea of “teleworking” or “telecommuting” or “working from home” is not new. The practice is still not very popular because most organizations lack a policy for “telecommuting.” There are two schools of thought fighting against each other related to the implementation of this practice in a broad sense. The main theme of this CABA White Paper suggests that technology is available to let employees, whose work is information-based, work at home for three or four days a week. While many employees are provided with cell and smart phones to be accessible while they work from anywhere when away from their desks, what is lacking is a cultural acceptance and clearly defined guidelines for telecommuting as part of business activities. The thesis of this paper is that the concept of home offices would become popular quickly if:

- The employer encouraged the employee to establish a designated workspace at home, possibly with an allowance from the employer for office furniture, computer, and communications equipment.
- Real-time high speed Internet access and high-quality video conferencing were available for the employee to access corporate servers or other information infrastructures, whether local or in the “cloud,” and to see and talk with supervisors, peers, subordinates, and clients as if he or she were working at the corporate campus.

The concept of intelligent home offices presented in this paper can benefit employers and their employees. Telecommuting may impact society in general, including the rental price of offices in the central business districts, traffic congestion, and air pollution on roads and freeways, rental price of low-rise office buildings in the suburban area, and the emergence of a new industry of multi-purposed conference centers. Once the practice is generally accepted by industry, employees working at home could then contribute to their employers cost savings, increased productivity, enhanced creativity, etc. This complements the concept proposed by three authors of this article [So, Katz, Wacks] in June 2014 that roof top photovoltaic (PV) panels of such houses could also contribute to the grand goal of “zero net energy buildings” for super high-rise office buildings in central business districts.

## What Led to this Topic?

Teleworking or telecommuting (working remotely from the office on campus of the employer) offers the benefit of potentially reducing personal transportation energy and commuting time significantly. A reduction of commuting travel by abating traffic congestion has been postulated [10]. Telecommuting has a broad dimension with respect to the place for work. In this article, the emphasis is placed upon “working at the intelligent home office.”

The first two authors of this article started to work on this topic in 2007 after a presentation at a P2E2 (Pollution Prevention and Energy Efficiency) seminar organized by the U.S. Consulate General in Hong Kong. In this seminar it was suggested that if a couple of officers normally work at home and commute to their corporate offices only one day per week, about 100 miles (160 km) of travel on each of the four (4) remaining weekdays could be saved. This is based on an assumption that the couple needs to drive 25 miles (40 km) each trip by each driver. It is further assumed that the fuel consumption is around 20 miles per U.S. gallon (11.7 l/100 km) on average. Based on an article by Rapino and Fields, available from the official Website of the U.S. Census Bureau [16], the mean distance of a single trip for commutes during 2006 to 2010 had been 18.8 miles while some extreme cases could go up to 70.9 miles or even over a hundred. The article quoted a study by Qing showing that “super” commuters were on the rise in the U.S., where a super commuter is defined as working in the central county of a metropolitan area, but living beyond the boundaries of that area. In this article, an average roundup mileage of 20 miles per trip per officer is used. In other words, the couple mentioned above need to drive 80 miles per day.

If such mileage were unnecessary, the fuel saved per day would amount to four (4) gallons (15.2 litres) of gasoline per day (assuming 20 miles per gallon for a distance of 80 miles). This fuel could be used at an electricity power plant to generate 48 kWh per day based on the energy capacity of 34.6 MJ/l (125 kBTu/gallon) of regular gasoline and an average efficiency of 33% of a typical oil-fired power plant. 48 kWh is equivalent to a continuous consumption of 2 kW over



24 hours. According to the U.S. Energy Information Administration [17], the average annual electricity consumption for a U.S. residential utility customer was 31 kWh per day in 2012, fully covered by the 48 kWh of energy saving by telecommuting. Besides savings in gasoline, associated problems such as traffic congestion and air pollution from automobile exhaust could also be mitigated. This concept, together with idea of developing an intelligent residential community (So 2007), was published by CABA in 2007 [1] and in a textbook published by Johnson Controls (So et al 2009) [2].

In June, 2014, three (3) authors of this article produced a white paper for CABA entitled “Toward Zero Net Energy (ZNE) Super High-Rise Commercial Buildings.” [3] The conclusion is that it is almost an impossible mission to turn a 50 story super high-rise office building into a Zero Net Energy Buildings (ZNEB) by utilizing contemporary technology even if the energy target of 21 kBtu/sf/yr (239 MJ/m<sup>2</sup>/yr) could be achieved. One solution proposed in the article addresses a collaborative plan that all managers working inside the office building have an obligation to contribute to making it ZNE by feeding electrical power generated at their homes to form a ZNEB cluster. If all homes of officers of middle management or above could then be associated with the super high-rise office building where they work, why not extend this association and contribution to ZNEB by using a home office regularly? The latter two (2) authors bring their North American work experience and perspective to this discussion on such contributions and highlight some of the business norms or policies that may differ on supervisory human resource relationships, corporate expenses, tax treatments, and corporate social responsibility to issues such as greenhouse gas reductions and climate change.

As stated above, the concept of a home office is not new. Before our model is discussed, let's review on the popularity of “working at home” over the past decade.

## Popularity of “Working at Home” – Pros and Cons

According to a research conducted in 2009 by Herman Miller [4], “The home office, enabled and untethered by technology, has expanded its reach throughout the home, reflecting the ongoing blurring of the lines that separate home life from work life.” Based on a survey involving 250 at-home workers, 87% declared that they worked in their home offices. The article also noted that working from home can improve the morale of employees since their company trusts, respects and appreciates them, and wants to help them pursue the work/life balance they seek. It was suggested in the article that telecommuting could also be a crucial component of corporate cost savings by reducing real estate and utility costs, generally estimated to be about \$10,000 per employee annually. Also, telecommuting can be a key element of a company’s environmental commitment by reducing fuel use, pollution, and carbon emissions. Working from home can facilitate focused, efficient work on projects and reduce traffic congestion. According to Sun Microsystems [6], its home-based workers gave back to the company about 50% of the time they saved by not commuting and used the other half for themselves and their families.

A study was done in 2010 by the Executive Office of the President of the United States [9] about flexible workplace arrangements considering when one works, where one works, and how much one works. Such flexible arrangements may include job sharing, phased retirement of older workers, and telecommuting. It was found that lower skilled workers had less workplace flexibility in terms of scheduling when they work than do more highly skilled workers. And flexibility in where to work was less common as only about 15% of workers reported working from home at least once per week. Lots of employers considered costs and limited funds as obstacles to implementing workplace flexibility arrangements. According to the report, the benefits of adopting such management practices could outweigh the costs by reducing absenteeism, lowering turnover, improving the health of workers, and increasing productivity. The true obstacle may lie with the inadequacy of relevant data and a widely acceptable culture.

Jen Augustine published on Feb 21, 2014 in Fast Company [18] an article entitled “How to build (and sustain) a remote workforce” with the opening sentences, “Despite the 2013 uproar caused by Yahoo CEO Marisa Meyer’s decision to ban the company’s remote working policy, telecommuting is still thriving, and it’s easy to see why. According to Global Workplace Analytics and the Telework Research Network, telecommuting increased 80% from 2005 to 2012 and it’s estimated that regular telecommuters will total 3.9 million by 2016, which is a 21% increase from the current (2012) level.” In 2006, there were 12.4 million corporate teleworkers in the U.S., an increase of 10% over 2005 (WorldatWork 2007 [5]). A 2008 IDC (International Data Corporation) survey showed that 81% of the Asia Pacific executives believed that telecommuting would improve productivity, up from 61% in 2005. An increase in support was especially high in Hong Kong, Australia, and India. Though there are various benefits, the challenges to telecommuting should not be underestimated.

At present, there is still in a lack of trust in the office culture, which is critical between the employer and employees. Some employees worry about the loss of their status in the office, making them reluctant to leave the headquarters or the regional campus. Some may even have the fear that leaving the office means being isolated from their manager and colleagues, which could seriously affect their chances for career advancement. Face-to-face communications between colleagues inside an office environment is still considered the most creative, effective, and productive activity. If working at home, they may start to lose a sense of belonging to the working community. Even some who are willing to work at home are not satisfied with their ill equipped home offices as compared with the smart furniture and environment at the corporate campus.

As noted by the Ioffice ebook [15], there are eight (8) metrics in particular that every facility manager should track, including i) real estate costs and terms, ii) space utilization, iii) real estate costs, iv) everything about every asset, v) the facilities team’s performance, vi) sustainability goals, vii) optimal space use, and viii) the quality of space. They also quote the following about space from facilitiesnet.com [19]:



“Square footage is shrinking in today’s workplaces. Workstations used to be 80 to 100 sq. feet, but are now around 40 to 50 sq. feet as PCs are replaced with laptops or tablets and employees’ preferences change. Workers don’t necessarily want a corner office anymore; they want dynamic environments that offer freedom and stimulate creativity.”

While employees fear losing identity in the office, their managers may at the same time fear losing control and authority. A general policy of telecommuting may weaken their ability to motivate and supervise their subordinates, eventually leading to a lowering of the managers’ own status and promotion within their organization. That’s all due to the current unsatisfactory real-time communication arrangements between remote workers even though appropriate technology exists.

It had been reported that larger companies are often thought to provide better benefits overall [8], but when it comes to work-life balance, smaller companies are more tolerant and flexible. The survey found that more small companies (50 to 99 employees) offered everything from flextime and a compressed work week to sabbaticals and phase in/out options (e.g., from maternity leave or to retirement) than large companies did. The explanation is that employees in small organizations are more likely to have “greater access to a culture of flexibility,” (i.e., support from immediate supervisors and a workplace culture that provides support for succeeding at work and at home). Small employers provide more flexibility presumably because, unlike large companies with multiple layers of management, they could easily see what is beneficial both to the organization and to the workers, and they are often willing to implement new policies for small groups of employees.

Over the past decade, changes in technology have had a dramatic impact on the way we work. Mobile devices such as smartphones, laptops, tablets, and powerful social, video, and cloud-collaboration applications and services have made it possible for people to work wherever they are provided, especially if the devices are online (Herman Miller 2012 [11]). There is no difference between employees using their tablet in the corporate office or at home, provided

that the broadband quality at home is compatible. Relevant technologies available for facilitating telecommuting may be categorized into three (3) groups:

1. Smart devices that are portable, such as phones and tablets, and cloud-based applications give people unprecedented choices over how, where, and when they work. In early 2011, for the first time in history, smart phones outsold personal computers. It is foreseeable that tablets will likely outsell laptops by 2017. Cloud services furthermore give employees a central database to access information necessary for their work.
2. Unified communication channels are types of software that enable people to connect with each other in real-time. In this way, a team can work even if members are not physically at the same location. Fifteen years ago, people still communicated by phones and e-mails. Now, with tablets, smartphones, laptops, e-mails, instant messaging on SMS text, and apps like WhatsApp, WeChat, Line, Twitter, Facebook, etc., people can get in touch with one another freely, both visually and verbally, independent of their locations. Video conferencing software such as Skype, Webex, Adobe Connect, GoToWebinar, TokBox, MegaMeeting, Zoom, etc. bring members of a team together virtually inside a meeting room where files, presentations, and discussions can be shared. There is negligible delay in both visual and audio communications.
3. The emergence of natural forms of interfacing such as touch, voice, and gesture interfaces effectively change the ways people interact with technology in the office. A touch screen may soon totally replace a mouse, which is very often more powerful than a keyboard. Now, both the keyboard and the mouse can be built on a big touch screen.

Cisco published a CVD (Cisco Validated Design) in 2004 that expanded the workplace to include the home office so employees could join the corporate network securely, allowing them to

remain productive even when not physically on campus. Although this helped to transform the workplace, devices available in the past limited the solution. Often an employee needed to carry the same laptop back and forth between the campus and the home office. While the network (wired and wireless) kept devices connected, data such as e-mails and documents still physically resided on a hard drive in the device. A recent Cisco Mobile Workspace Solution using the Citrix Design Guide [7] addressed this limitation. The employee's device functions as a channel or conduit that allows the employee to interact with the huge corporate data pool regardless of the type of device used. The content from this data pool represents intellectual property, which is a corporate asset that must be protected. The current CVD, called XenMobile Enterprise Edition, is divided into several sections that cover on-campus and remote devices using both native applications and virtualized desktops. However these are not mutually exclusive deployment models, so a truly seamless mobile experience is available to the users.

Evidence so far indicates that "working at home" is totally feasible with all available technologies and a growing culture of acceptance. All tasks that are information-based could fall within this category; in other words, most information-based workers can work at home for a substantial portion of time. But in order to tackle the obstacles, appropriate design and planning are necessary.

## The Ideal Home Office Model

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Based on the discussion in the last section, an ideal home office should include the following functions:

1. Seamless access to the data pool of the organization – telecommuting is mainly applicable to workers who process information, which accounts for a majority of workers in offices. Here, information includes not only data, documents, brochures, drawings, etc. in the archives of the organization but also ideas and documents exchanged among employees during brain-storming meetings and between employees and customers during business meetings.
2. A virtual campus environment – the employees must have a feeling that they are actually participating in the corporate activities though they are physically at home. Their commitment should not change as the home office is not a place for entertainment or relaxation. However, the home office does offer flexibility that may encourage an increased focus on work rather than wasting time with breaks and “water cooler gossip.” They know that the main objectives of such arrangements are for the efficiency of the organization as well as the benefit of the employees who could spend less time on daily commuting and have more time for family life. In this case, the organization must ensure that at-home workers have the proper environment and tools they need to be involved and productive. Ergonomic support is also necessary for the health of the at-home workers. Workers are more willing to work overtime at home rather than at the corporate office, for example, by attending midnight international teleconferences, etc., because the home and office are only steps apart.
3. Uninterruptible connection between the home workers and the corporation – such connection has to be maintained continuously so that an at-home worker does not

get any feeling of being isolated. The employee needs opportunities for real-time connections with his or her supervisor, peer colleagues, and subordinates with the aid of online communications that may include video conferencing. With a high-speed Internet connection and video conferencing software, at-home workers can participate in effective video conferences with anybody working in another home office or at the corporate campus.

4. Freedom from commuting – working at home is not a penalty; it is just for efficiency. Clear criteria and policies must first be developed by the organization on how potential employees are selected for telecommuting based on work nature, style, ethic, and desire. The final decision must be made by the employee, not the employer. Even if a worker chooses to work at home, that does not mean that the seat in the corporate campus is permanently removed. Some companies have reduced corporate office space by encouraging telecommuters to use offices from a pool that accommodates the percentage on campus. The manager can designate certain days, or parts of days, when telecommuters return to the campus to participate in traditional office activities in person.

To address function #2, one or two designated room(s) inside the house of the employee(s) is (are) converted into a formal home office.

Some employers may provide a subsidy for home office furniture. A large working desk is recommended, say 10 ft (3 m) wide and 3.3 ft (1 m) deep with a shelf and stationery holders above the desk or a work station for computers and video screens. An ergonomically designed office chair is recommended for employee comfort and productivity. The room environment such as temperature and sound insulation is a function of the house design. However, if needed, an HVAC system (such as a split-type reverse cycle air-conditioning unit for heating and cooling with fresh air supply and room air extraction, and a small circulation fan if necessary) could be added so that a comfortable environment is guaranteed year long, say with a uniform

air and radiant temperature at 72 °F (22 °C) and an air speed of 20 fpm (0.1 m/s), humidity preferably controlled to 50% - 60% by the use of a humidifier. Passive or active sound silencers may be installed if necessary to ensure the indoor sound level is always below NC-45. Shading is recommended to avoid glare on computer and video screens. Dimmable lighting would help to provide uniform illumination according to standards, say around 500 lx. The employee should be encouraged to furnish the room as comfortable as possible including wall art, green features, and picture frames to enhance the indoor environment that might contribute to work efficiency and creativity. When a human being sits in front of all these artistic accessories, the mind should become clearer and focused on work. Power for some of the equipment would be provided by roof-top photovoltaic panels if the employee's house is participating in the corporate ZNEB program.

Figure 1(a) shows the top view of the home office design and Figure 1(b) shows the side view. These layout plans are conceptual for reference by the designer. More facilities could be added from time to time.

The office equipment, which might include: two 21" monitors with built-in loudspeakers; a Web camera for video-conference; telephone by land line or VoIP; printer; scanner; fax (through fax use is declining); keyboard; and a wireless router and modem, which is the most important facility in the whole home office. The high speed Internet connection depends on the neighborhood Internet Service Provider (ISP). In North America, the average broadband speed is increasing, but is still limited to a few Mbps in most areas. Some ISPs are starting to offer services of 15-150 Mbps via fiber optic links to the home. The most prominent is FiOS from Verizon and Frontier, but as of 2013, it served only five (5) million U.S. customers. Google is planning very high-speed service (up to 1 Gbps) in selected cities. Some Asian and European countries offer better and less expensive Internet services than in North America. To facilitate such information technology, structured cabling using two (2) CAT 5E or CAT 6 cables (each with four (4) pairs of 100 ohm UTP) according to ANSI/TIA-570-C Grade 2 residential cabling system is recommended. Although Wi-Fi could support all devices on a home local area network, a wired



network is more reliable with assured availability. Desktop computers and video teleconferencing should use the wires while portable devices use Wi-Fi.

A well-equipped, comfortable, and personalized home office will enhance employee productivity at home and may encourage work beyond the usual working hours such as evenings and weekends if needed.

So far, all benefits are considered from the employee's point of view. The next section will show us why and how the employer would appreciate this model.



## Benefits to the Employer

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In order to encourage employees to stay and work at home, some corporate support is needed, especially for telecommunications and IT. As employees assume more flexible working hours, corporate IT departments must ensure that servers and business data are available 24/7. An emergency maintenance team should be established within the organization, which is always available to tackle any technical problems encountered in these remote offices, such as machines failure, network failure, software failures, virus attack, etc.

The size of a home office depends on the employee's living environment. A minimum size of about 100 sf (9.3 m<sup>2</sup>) is recommended. The use of home offices allows organizations to have more flexible expansion plans and perhaps eliminate the need to choose another suitable site for a bigger campus. When an officer is being employed with the option to work at home, he or she can simply start working by using equipment (furniture, computers, broadband etc.) subsidized by the company after a quick renovation to the home office. The distribution of officers can be anywhere around a city, a country or even around the world. The best talents could be hired irrespective of their physical locations.

If the employees work mainly at home and commute to the central office, say once or twice per week, office space required at the headquarters or regional offices can be consolidated, thus reducing overhead costs.

The overhead costs for a corporate office include, but are not limited to:

1. Rent, internal decoration and furniture
2. Electricity and gas charges
3. Sundry expenses
4. Installation of heating, ventilation and air-conditioning
5. Installation of lighting
6. Water charge

7. Maintenance fee for equipment
8. Insurance for all equipment
9. Broadband service
10. Beverages and items in pantries

There is a reduction of expenditure in most items by promoting the concept of home offices. Less office space is required, so is the overhead cost. To a certain extent, the employee who works at home instead of staying in the campus may share a portion of daily operating cost of the campus. It should be noted that the rent of a Class A office at the downtown or central business district is normally much higher than equipment costs for supporting an employee working at home.

With the improved quality of working life and autonomy, employees could have an improved planning and working schedule, resulting in a less intense working environment.

Since an employee no longer needs to commute between home and office, normally taking one (1) to three (3) hours a day due to rush-hour traffic congestion, he or she can sleep longer. A regular office shift is 40 hours per week; a saving of three (3) hours per day x four (4) days of home working per week = 12 hours per week has already implied an increase of productivity by over 25%. But of course, we cannot assume that all the saved commuting time is converted into office hours by the employee. Nevertheless, an employee working at home may enjoy leisure time right after work instead of dealing with traffic on freeways, being squeezed in a bus or train, or doing nothing in a carpool. The saving in commuting time can provide a healthier and content worker. That explains why a home office can improve productivity, implying an increase of the revenue of the company by utilizing remote workers. It is rather obvious that employees are more willing to work overtime at home rather than at the campus.

A recent study conducted at Stanford [12], based on the results of a working from home (WFH) experiment at Ctrip, a 16,000-employee, NASDAQ-listed Chinese travel agency, reported that working at home led to a 13% performance increase, of which 9% was from working more

minutes per shift (fewer breaks and sick days) and 4% from more calls per minute (attributed to a quieter and more convenient working environment). Home workers also reported improved work satisfaction, and their attrition rate was halved. Based on the success of the experiment, Ctrip rolled out the option to WFH to the whole firm and allowed the employees who participated in the experiment to re-select between home and office. Interestingly, over half of them switched, which led to the performance gains from WFH almost doubling to 22%.

While a home office investment will provide the workspace and organizational structure certain benefits, the implementation of telecommuting must also recognize the nature of the work as companies in the high-tech and creative businesses may want the employees to be on site.

## Impacts on the Society

A rapid growth in popularity of home offices may mean the demand for large office space in the central business district (CBD) decreases. Employees of large enterprises may want to stay where they live, to work for the majority of time, and therefore less office space is needed for large enterprises. Usually, these large enterprises tend to occupy at least several to tens of stories of office space in a super high-rise office building in the CBD. Enterprises tend not to occupy the whole building unless the building is their headquarters or a regional head office. Telecommuting at 80% of time means that a connected shared workspace policy can be adopted. The same seat in a regular office can accommodate five (5) officers instead of one (1).

Cisco conducted a case study [13] on such shared workspace strategy and reported that there was a saving of 37% in real estate rent because more people could be accommodated in the same amount of space. This amounts to a savings of 42% in construction because a smaller building was erected, a savings of 37% in workplace services due to the reduction in utilities and maintenance costs, a savings of 50% in furniture procurement because less furniture was needed in cubicles, a savings of 40% in IT capital as fewer switches and switch ports were needed, a saving of 60% in cabling, and a saving of 50% in equipment room space.

Even though equipping a room for each employee's home office with technology requires extra funding, such costs are compensated easily by the reduction in the rent paid at the CBD, according to a case study conducted in Hong Kong. In that case, the employer invested about US\$12,000 in renovating a home office of about 100 sf, and calculated a monthly operating cost of US\$600 for support of the office at home. The average annual rent of a grade "A" office in the CBD in Hong Kong is about US\$200 per sf. per month. Let's use a cycle period of two (2) years. The total cost spent on the home office by the employer is equal to  $\$12,000 + \$600 \times 24 = \$26,400$ . The net rent of a grade "A" office of the same size at the CBD in Hong Kong is equal to  $\$200 / \text{sf} / \text{yr} \times 2 \text{ yrs} \times 80 \text{ sf}$  (an employee still needs an equivalence of 20 sf for commuting back to campus once every week) =  $\$32,000$  which does not include additional space for corridors and pantries, electricity, cleaning and other facilities. If the service of an employee is much longer than two (2) years, the benefit to the employer is certainly very attractive.



When the demand for large office space decreases, the rental price of these offices decreases accordingly. Traditionally, middle-sized companies cannot afford the high rent in the CBD and therefore, they usually occupy small office space close to the perimeter of the CBD. Once the rent of large office space in the CBD decreases due to less demand, middle-sized companies tend to enter the CBD. Super high-rise office buildings in the CBD are then subdivided and occupied by more small or middle-sized companies. Multi-tenancy in commercial centers of the CBD, versus the traditional limited tenancy by anchor tenants, will become the norm. The commercial real estate market outside the CBD will also be affected. Office buildings in the suburban area, initially occupied by middle-sized or small companies, may gradually become vacant because those companies moved into the CBD to achieve a higher reputation and better image due to the existence of rapid transportation systems. Some land in the suburban area may even be converted to residential use, and the rent for commercial real estate would decrease.

There would be a general decline in CBD office rentals. This will enable enterprises in the CBD to be more competitive, i.e., firms can produce at generally lower costs. Rents in the CBD would fall, but those in suburban areas may rise due to the addition of home offices. Gross rental income in the region may rise because both urban and suburban lands are much better utilized. Hence, there would be positive effects on employment rates and on the GDP.

Besides commercial real estate, the residential market will also be affected by the popularity of home offices. Newly built houses, designed with one or two designated room(s) for home office with all cabling facilities, etc., naturally have a high price due to the high level of demand and higher construction cost. As a result, expect more existing residential houses to be renovated to attain the same quality to claim a higher price. Those below standards will suffer a drop in price due to a reduction in demand. More suburban and remote areas will be developed because poor transportation is no longer a critical factor, as residents do not need to commute to the CBD on a daily basis. The decision on purchasing a house will mainly depend on the quality, but not the location.

People will tend to stay at home during office hours and therefore the traffic during rush hours will be significantly improved. The demand for transportation between residential communities and the CBD decreases, thus decreasing transportation expenses. The frequency of transportation of employees will

be reduced but not down to a very low value because although people usually work at home, they still need to go back to the CBD once or twice per week. They also need transportation to obtain daily groceries and for entertainment. People will choose to live in suburban areas or even further away from the CBD in order to enjoy larger space, nicer views, better air quality, and lower house prices. That however implies that people may need to travel a longer distance from home to office whenever necessary. The overall transportation network will extend further away from the CBD and the network coverage will expand.

As the total traffic demand decreases, the overall emissions from vehicles decrease proportionally, and the overall air quality is improved. Harmful exhaust gases, including hydrocarbons ( $C_xH_y$ ) and oxides of nitrogen combined ( $NO_x$ ), carbon monoxide, volatile organic compounds, sulfur dioxides, and suspended particulates (mostly soot) are reduced.

The construction industry will see an increased demand for IT-equipped residential houses and apartments. People are willing to invest more in their own residential buildings as they spend more time living and working there. The domestic environment will become green, friendly, comfortable, safe, secure, and be ready for the installation of new equipment. The interior decoration would be more pleasant, friendly, while the heating, air-conditioning, ventilating and lighting systems are improved to suit the users.

A new industry may be developed: the construction of multi-purposed conference centers. These centers could be located at shopping malls, close to where people live. Since employees no longer work in the CBD for most of the time, they may choose to meet their clients and colleagues in conference rooms inside these multi-purposed conference centers nearby. The low-rise office buildings originally located away from the CBD may be converted into such conference centers so that employees of different companies can reserve rooms for meetings and seminars, etc. on an ad hoc basis. These centers must be fully equipped with all IT services and office automation systems. The IT security level must be high as employees from different companies may use the same system at different times.

The operating cost of multi-purposed conference rooms is quite low. The service provider only needs to manage the reservation of these conference rooms online, maintain the indoor condition, and ensure the facilities inside, such as projectors, monitors, broadband routers, audio systems, etc. are functional.

They are like hotels for business, not for accommodation. Of course, those large sized companies may rent certain conference rooms in these centers permanently so that any in-house staff can reserve the rooms online within the private network of the company for daily use.

## Conclusion

“Working from home” or “Telecommuting” is nothing new. For now, there are still two opposing opinions, for and against the practice. There clearly are rapid changes in both the technologies enabling the telecommuting and the move towards less hierarchical business organizations that show younger workers inventing and designing these technologies want a more collaborative physical workplace. A recent blog [14] by Rawn Shah, “The Workplace Of The Future Is Still The Office,” outlines many of these trends that support both sides of the telecommuting issue. His opening position is noted here: “Every time I read about the future of work, I see a focus almost entirely on remote work, virtual workplaces and stories of people working from coffee shops. Yes, overall, this is a rapidly growing trend, increasing by over 60% in recent years. I personally have worked remotely for almost two decades, but in general this is still pretty infrequent.”

Lots of concerns were raised in the past about facilities, employee’s feeling, commitment, costs, productivity, and others. Today, not many companies have a clear policy on “telecommuting.” Without a strong administrative and financial support from the employer, the overall performance of “working at home” is still not satisfactory. With the advancement of information technology this article explains that all these problems are manageable and have already been solved provided that there is strong support by the employer.

The provision of a high quality home office for the employee can save costs, increase productivity, and show respect and trust by the employer, as discussed in detail in this article. The office in the home is in effect contributing to the success of the organization.

This shared responsibility concept is similar to the white paper prepared by three (3) co-authors of this article, “Toward Zero Net Energy (ZNE) Super High-Rise Commercial Buildings” published in June, 2014 by CABA [3] that the residential house of employees above a certain rank in the organization should contribute electric power to the “zero net energy” goal in the future. The installation of roof-top PV panels feeding power to the home office is the first step, followed by the supply of extra power generated to the super high-rise office building in which the organization is located.

Finally, the authors of this article are not encouraging all employees to work at home 40 hours per week. Only those employees whose work nature is information-based might work at home on a voluntary basis while they still commute back to the campus once or twice a week. If meeting a group of clients or colleagues is necessary, the idea of multi-purposed conference centers suggested in this article may be considered. Our suggestions are not significantly different from those noted by Rawn Shah [14] who closed his blog by noting the following: “We are only starting to understand what the future of work looks like. In my view, the imagined idea of entirely virtual organizations is similar to how we used to think of the future as full of flying cars and colonies in space. Reality is much more invested in hybrid in-office plus remote scenarios. Physical space is still a strong element of work that we need to keep track of, and understand better to learn how we truly collaborate.”

The authors recognize the objectives of the employers and how they treat the human resource issues of travel, space, and productivity as the work force changes will require appropriate changes in telecommuting. Organizations like the Continental Automated Buildings Association that sponsored this white paper are always examining the trends that impact smart homes and intelligent buildings.

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